IN4MATX 241: Ubiquitous Computing

Week 1:
History of Ubiquitous Computing

Daniel Epstein

Today’s class

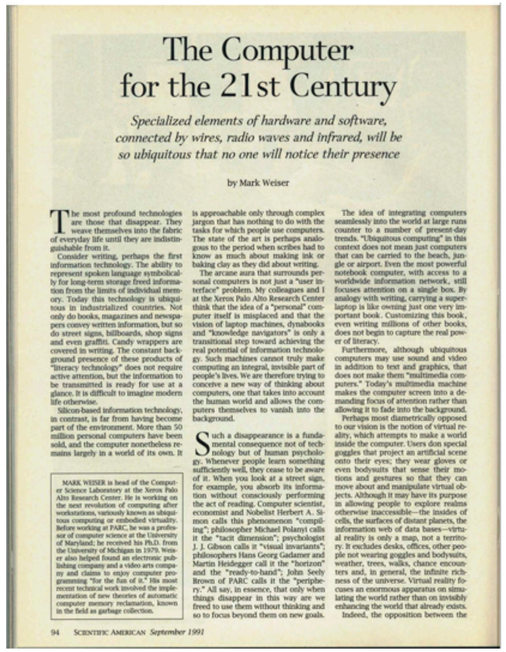
- Defining ubiquitous computing
- Course overview
- Break
- Discussion on the readings
- Project discussion

Discussion time!

What is Ubiquitous Computing?

The Computer for the 21st Century

- Published in Scientific American, 1991
- Coined “Ubiquitous Computing”
  - Reflective and speculative
- I hope you liked the early-90’s ads



The Computer for the 21st Century

Specialized elements of hardware and software, connected by wires, radio waves and infrared, will be so ubiquitous that no one will notice their presence

by Mark Weiser

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.

Consider writing, perhaps the first information technology. The ability to represent spoken language symbolically for long-term storage freed information from the limits of individual memory. Today this technology is ubiquitous in industrialized countries. Not only do books, magazines and newspapers convey written information, but so do street signs, billboards, shop signs and even graffiti. Candy wrappers are covered in writing. The constant background presence of these products of "literacy technology" does not require active attention, but the information to be transmitted is ready for use at a glance. It is difficult to imagine modern life otherwise.

Silicon-based information technology, in contrast, is far from having become part of the environment. More than 50 million personal computers have been sold, and the computer nonetheless remains largely in a world of its own. It is approachable only through complex jargon that has nothing to do with the tasks for which people use computers. The state of the art is perhaps analogous to the period when scribes had to know as much about making ink or baking clay as they did about writing.

The arcane aura that surrounds personal computers is not just a "user interface" problem. My colleagues and I at the Xerox Palo Alto Research Center think that the idea of a "personal" computer itself is misplaced and that the vision of laptop machines, dynabooks and "knowledge navigators" is only a transitional step toward achieving the real potential of information technology. Such machines cannot truly make computing an integral, invisible part of people's lives. We are therefore trying to conceive a new way of thinking about computers, one that takes into account the human world and allows the computers themselves to vanish into the background.

Such a disappearance is a fundamental consequence not of technology but of human psychology. Whenever people learn something sufficiently well, they cease to be aware of it. When you look at a street sign, for example, you absorb its information without consciously performing the act of reading. Computer scientist, economist and Nobelist Herbert A. Simon calls this phenomenon "compiling"; philosopher Michael Polanyi calls it the "tacit dimension"; psychologist J. J. Gibson calls it "visual invariants"; philosophers Hans Georg Gadamer and Martin Heidegger call it the "horizon" and the "ready-to-hand"; John Seely Brown of PARC calls it the "periphery." All say, in essence, that only when things disappear in this way are we freed to use them without thinking and so to focus beyond them on new goals.

The idea of integrating computers seamlessly into the world at large runs counter to a number of present-day trends. "Ubiquitous computing" in this context does not mean just computers that can be carried to the beach, jungle or airport. Even the most powerful notebook computer, with access to a worldwide information network, still focuses attention on a single box. By analogy with writing, carrying a superlaptop is like owning just one very important book. Customizing this book, even writing millions of other books, does not begin to capture the real power of literacy.

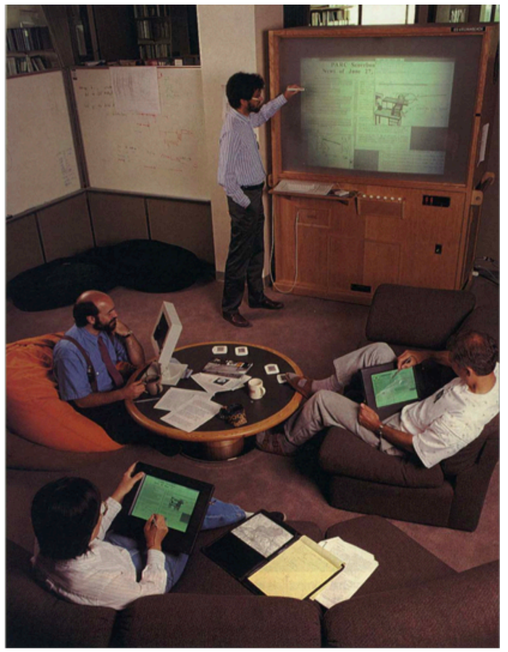
Furthermore, although ubiquitous computers may use sound and video in addition to text and graphics, that does not make them "multimedia computers." Today's multimedia machine makes the computer screen into a demanding focus of attention rather than allowing it to fade into the background.

Perhaps most diametrically opposed to our vision is the notion of virtual reality, which attempts to make a world inside the computer. Users don special goggles that project an artificial scene onto their eyes; they wear gloves or even bodysuits that sense their motions and gestures so that they can move about and manipulate virtual objects. Although it may have its purpose in allowing people to explore realms otherwise inaccessible—the insides of cells, the surfaces of distant planets, the information web of data bases—virtual reality is only a map, not a territory. It excludes desks, offices, other people not wearing goggles and bodysuits, weather, trees, walks, chance encounters and, in general, the infinite richness of the universe. Virtual reality focuses an enormous apparatus on simulating the world rather than on invisibly enhancing the world that already exists.

Indeed, the opposition between the

MARK WEISER is head of the Computer Science Laboratory at the Xerox Palo Alto Research Center. He is working on the next revolution of computing after workstations, variously known as ubiquitous computing or embodied virtuality. Before working at PARC, he was a professor of computer science at the University of Maryland; he received his Ph.D. from the University of Michigan in 1979. Weiser also helped found an electronic publishing company and a video arts company and claims to enjoy computer programming "for the fun of it." His most recent technical work involved the implementation of new theories of automatic computer memory reclamation, known in the field as garbage collection.

94 SCIENTIFIC AMERICAN *September 1991*



Three waves of computing

Mainframe computing

Personal computing

Ubiquitous computing

Three waves of computing

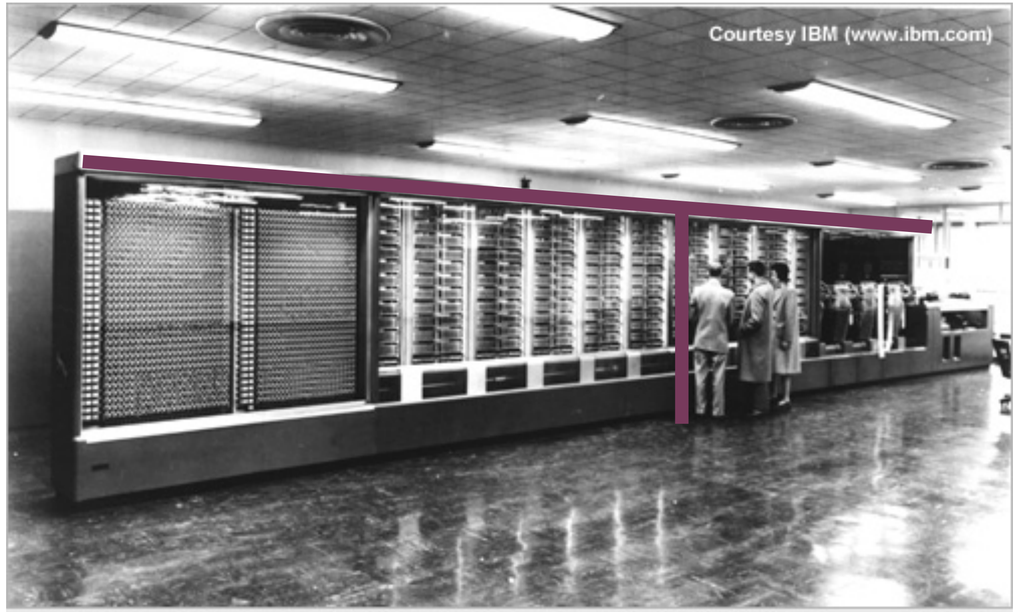
Mainframe computing

Personal computing

Ubiquitous computing

First wave: mainframe computing

- Harvard Mark I
- Large (55 feet wide, 8 feet high,5 tons)
- Expensive (enclosure alone was $50,000 in 1945!)
- Used to calculate implosion during the Manhattan Project

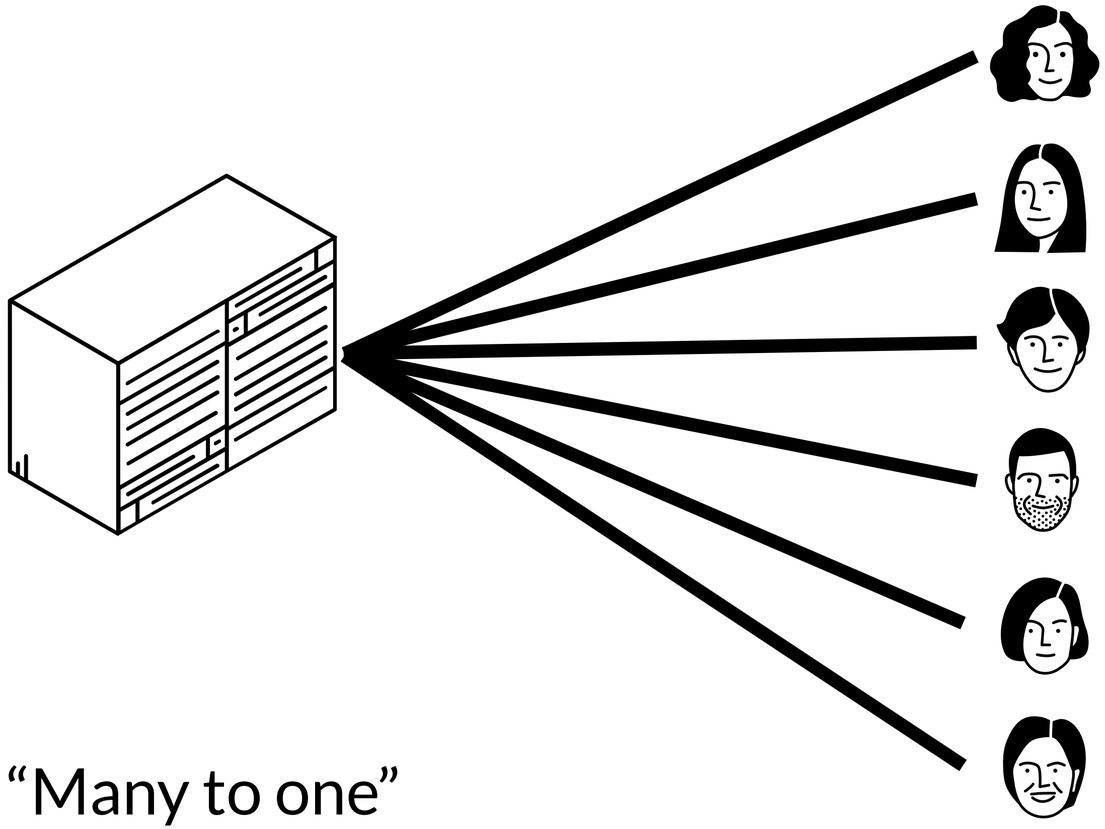


The Harvard Mark I

First wave: mainframe computing

- Batch processing
  - Write your program on punch cards
  - Wait your turn for the computer
  - Run program, hope it works
  - If it doesn’t, you’ll have to fix it and wait for your next turn
  - Efficient use of resources, but poor interactivity

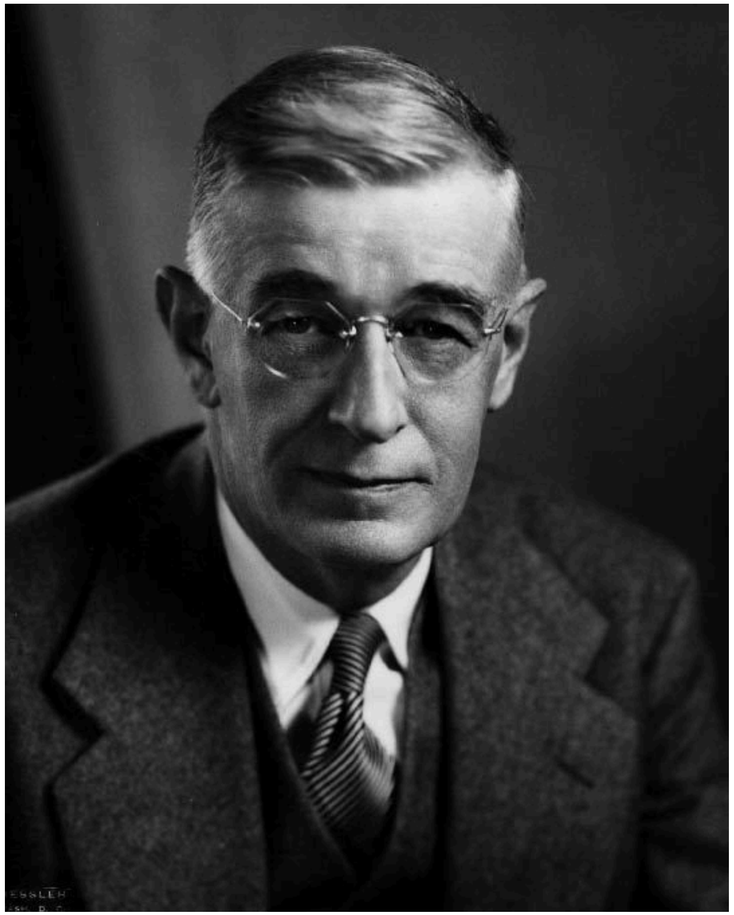
First wave: mainframe computing



“Many to one”

Vanneaver Bush

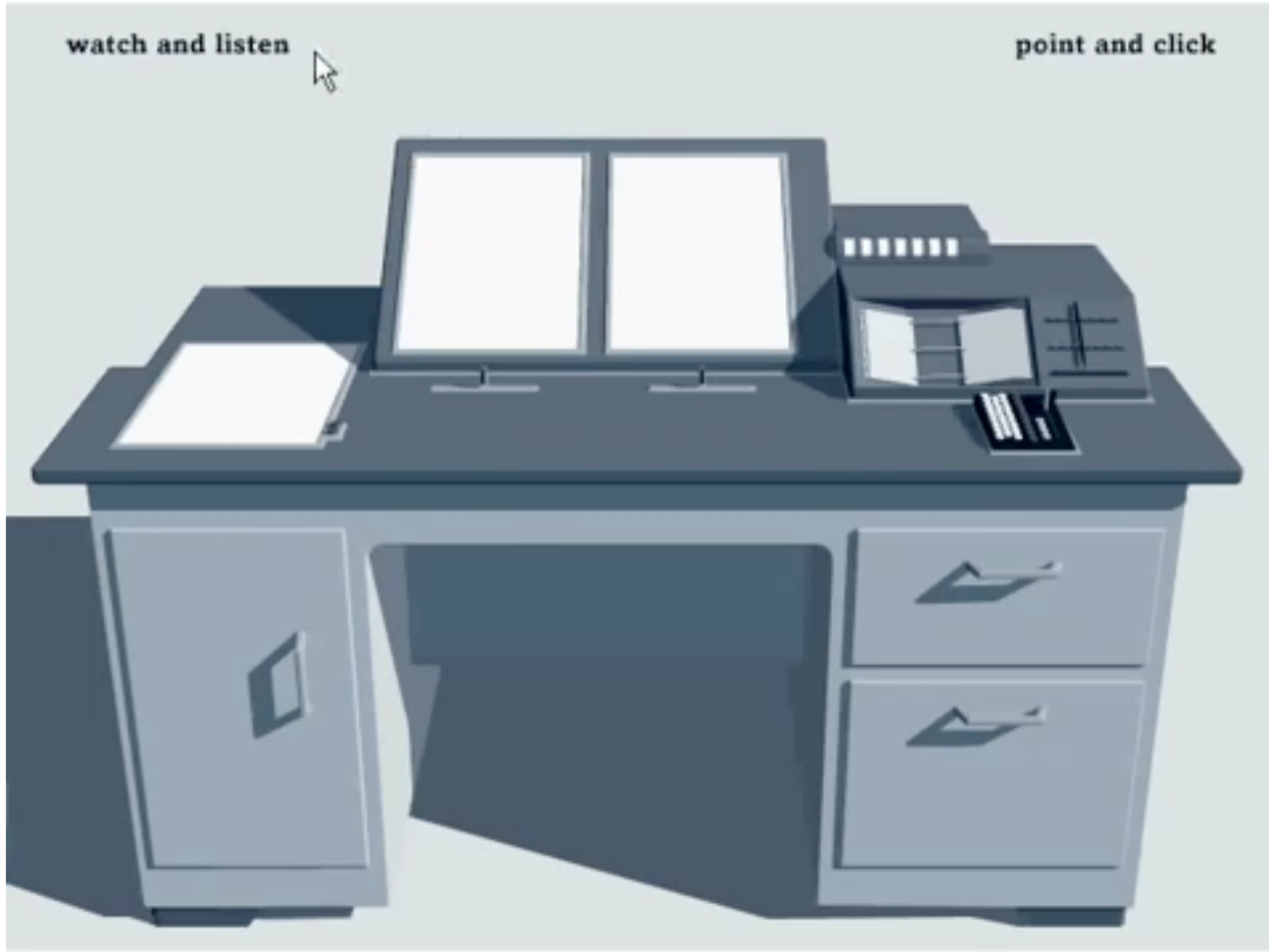
- Faculty at MIT
- Oversaw National Defense Research Committee, which led the Manhattan Project
- Post-war, helped define mission of the National Science Foundation
  - Federal government funds universities
  - Universities do basic scientific research
  - Research helps economy and defense



As We May Think

- Published in Atlantic Monthly, 1945
- http://www.theatlantic.com/magazine/print/1945/07/as-we-may-think/3881/
- In part, set out to define a post-war scientific research agenda
  - Speculative, not reflective

Memex (1945 speculative design)



https://www.youtube.com/watch?v=c539cK58ees

(video from 1995 animation presented at SIGIR, not from 1945)

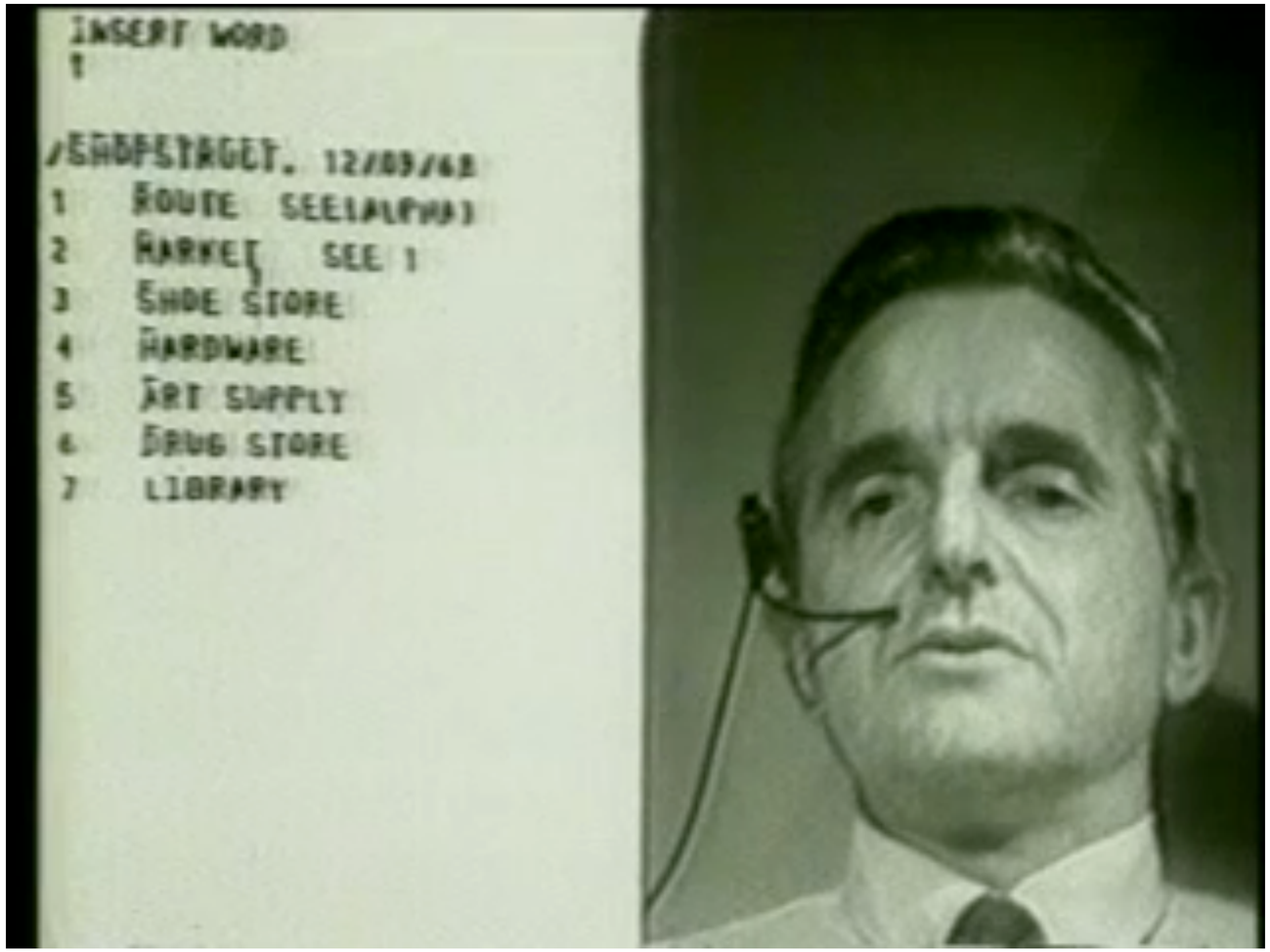
Memex (1945 speculative design)

- Linking information across devices and sources
  - Hypertext, the foundation of the web
- Pen-based annotation of primary sources

Command-Line interfaces (1960's)

- Originally used in a terminal connected to a mainframe
  - Was eventually integrated into personal computing (in Unix, etc.)
- A person could change execution based on output
- Enabled real-time debugging

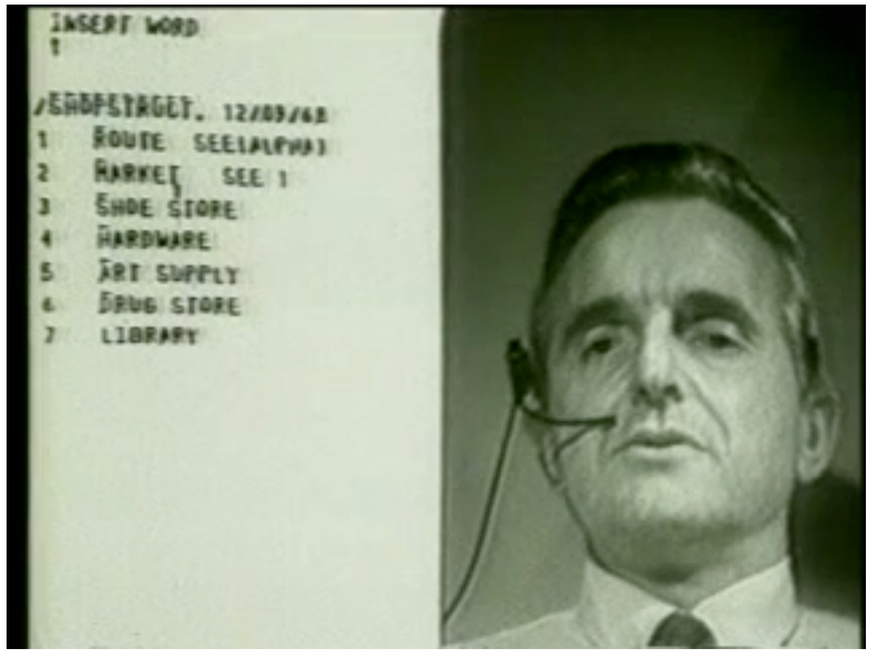
Doug Engelbart's NLS (1968)



http://www.dougengelbart.org/firsts/1968-demo-interactive.html

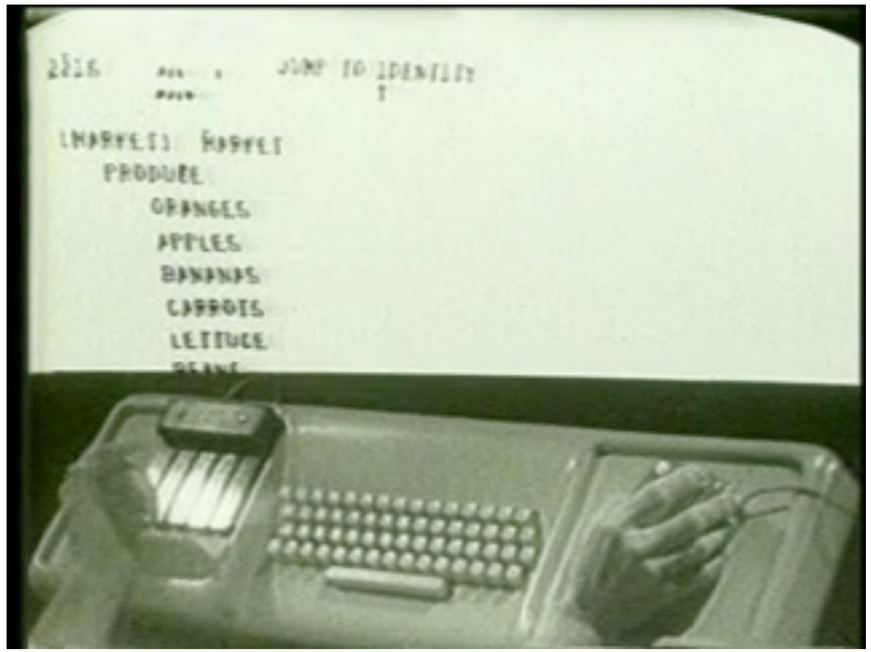
Doug Engelbart's NLS (1968)

- First working hypertext system
- Invention of the mouse
- Simple graphics
  (earlier systems had this,
  but used in a full system here)



Doug Engelbart's NLS (1968)

- It introduced other ideas as well
  - A chording keyboard
  - Remote collaboration
- Some people thought he "faked it"
- Others thought it was irrelevant because "the terminal can do the same"
- Won Turing Award in 1997



Three waves of computing

1

Mainframe computing

2

Personal computing

3

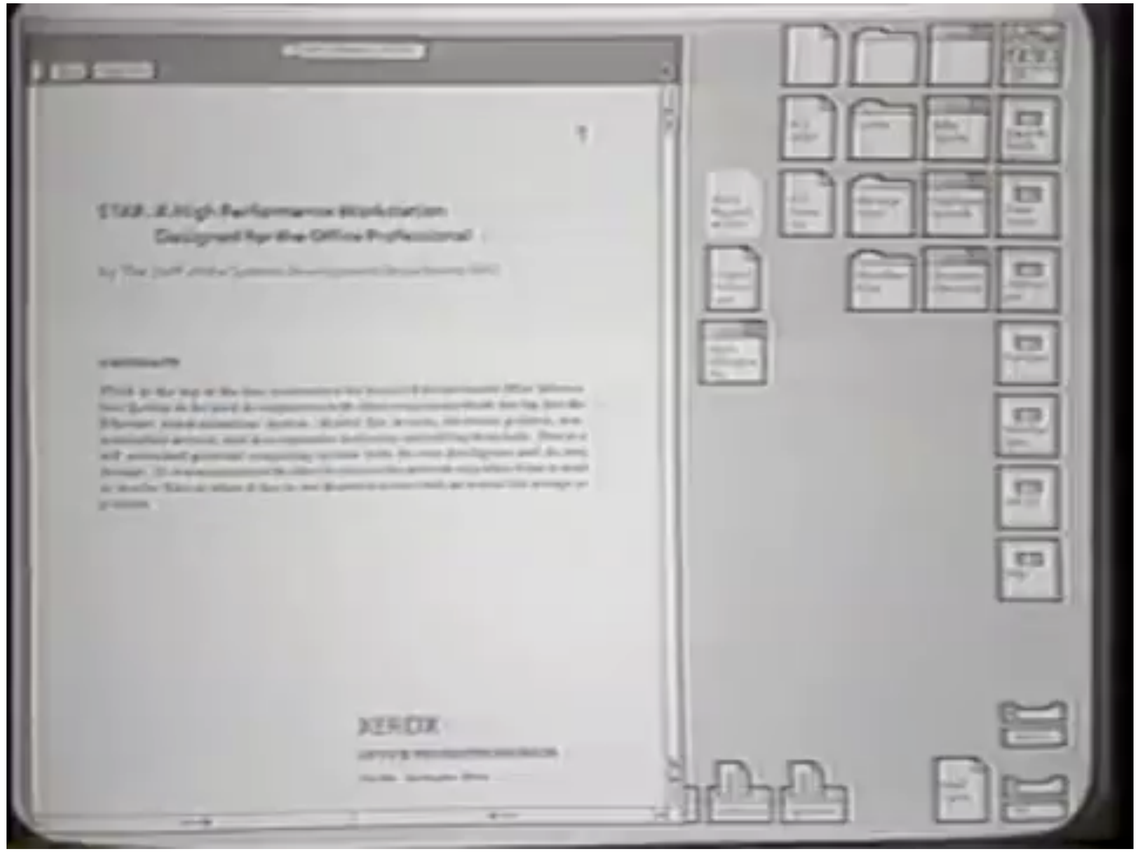
Ubiquitous computing

Second wave: personal computing

- First introduced by Xerox
- Xerox Alto, 1973
  - Mouse
  - Chording keyboard
- Xerox Star, 1981
- Xerox models were commercially unsuccessful
  - Still expensive, too few applications

Second wave: personal computing

Xerox Star (1981)

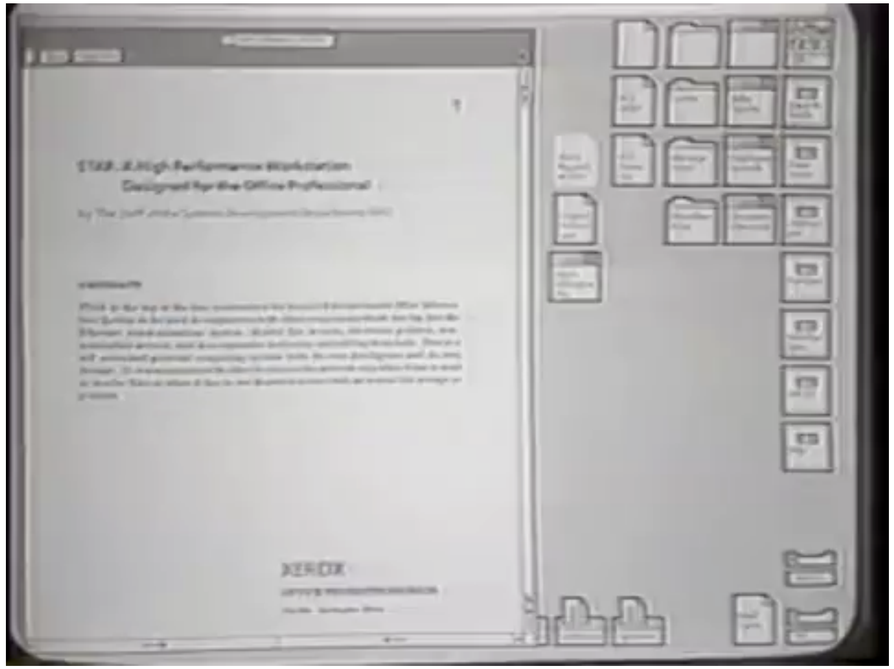


https://www.youtube.com/watch?v=ODZBL80JPqw

Second wave: personal computing

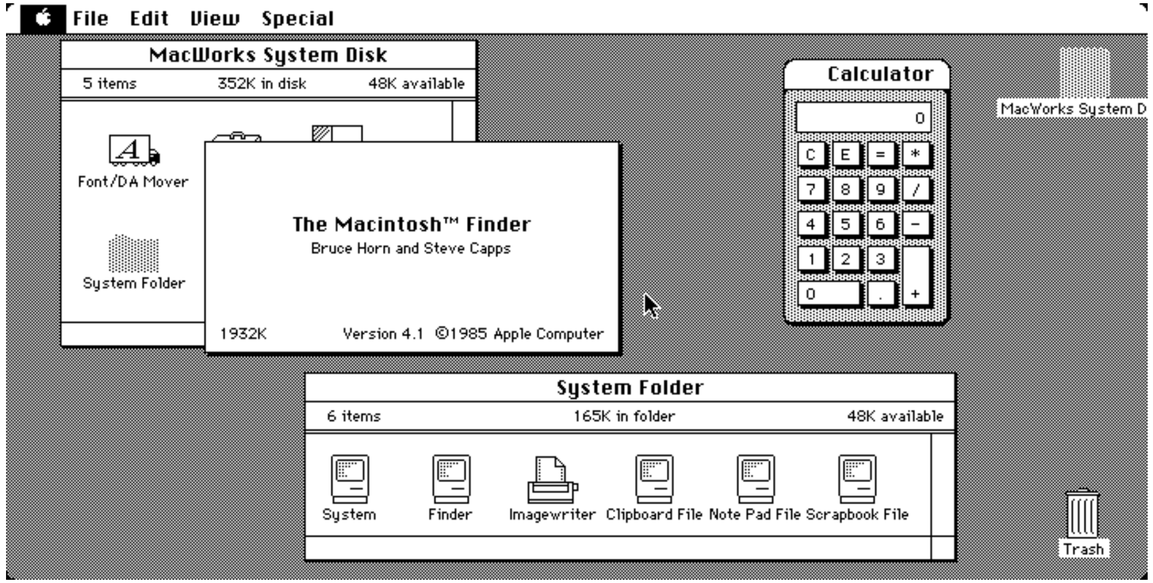
Xerox Star (1981)

- Software running in windows
- Desktop with icons for navigating between files and programs
- Super slow!



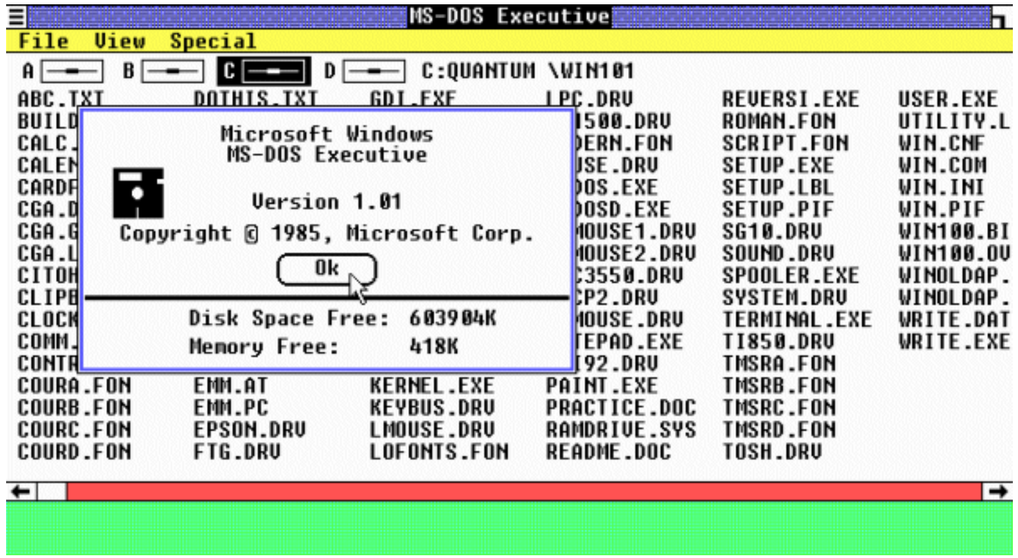
Second wave: personal computing

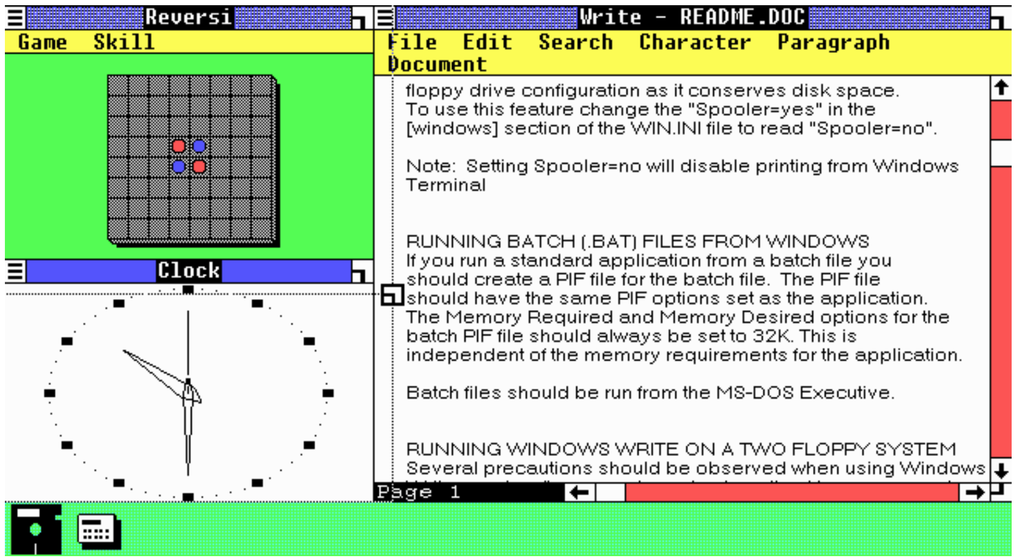
Macintosh (1984)



Second wave: personal computing

Windows 1.0 (1985)

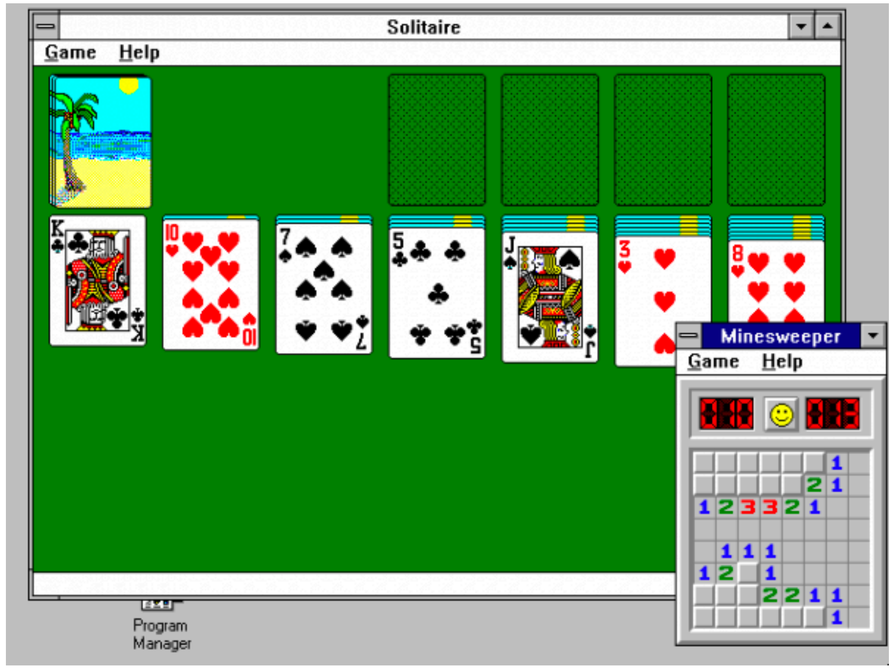




Second wave: personal computing

Windows 3.0 & 3.1 (1990 & 1992)

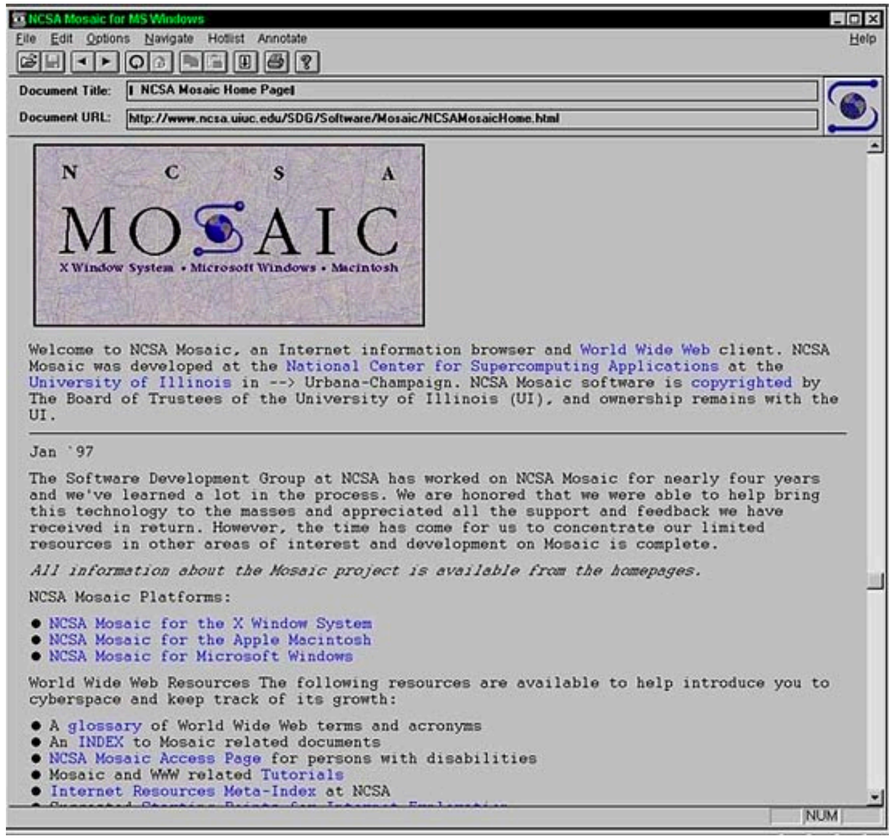
- Windowing became primary
- Added games: Solitaire, Minesweeper, and FreeCell!
  - These were a trick to teach mouse skills



Second wave: personal computing

Mosaic Web Browser (1993)

- Originally for Unix systems, later ported to Mac and Windows
- “First” graphical web browser
- Microsoft IE came in 1995
- Apple didn’t make a browser until Safari in 2003



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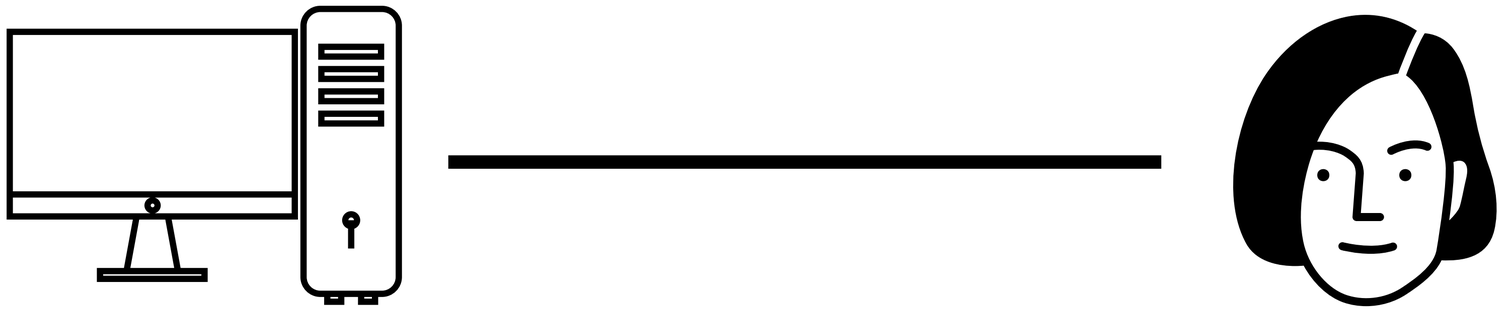


“One to one”

Three waves of computing

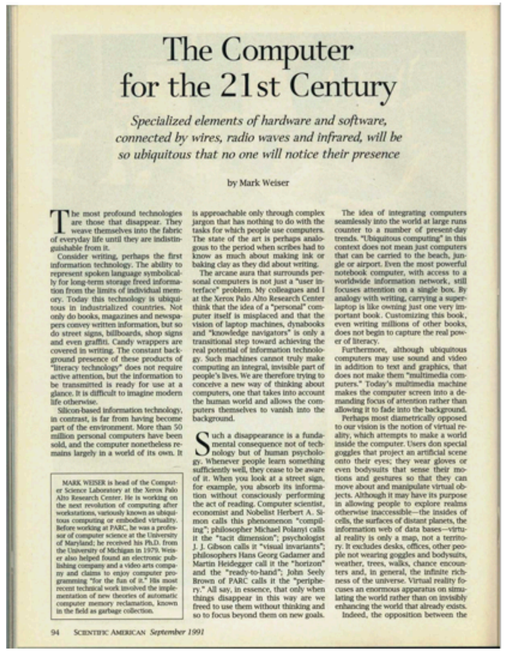
Mainframe computing

Personal computing

Ubiquitous computing

Third wave: ubiquitous computing

- Weiser speculated people would interact with three types of computers
  - Tabs: inch-scale devices, like post-its
  - Pads: foot-scale devices, like paper
  - Boards: yard-scale devices, like whiteboards
- Speculated devices would have shared ownership



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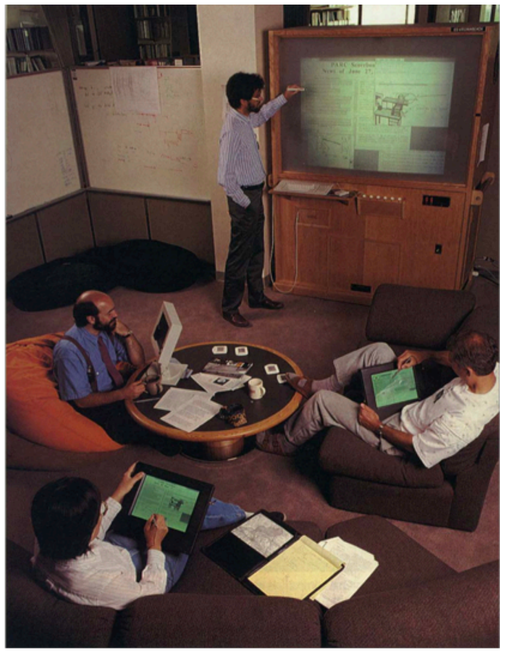
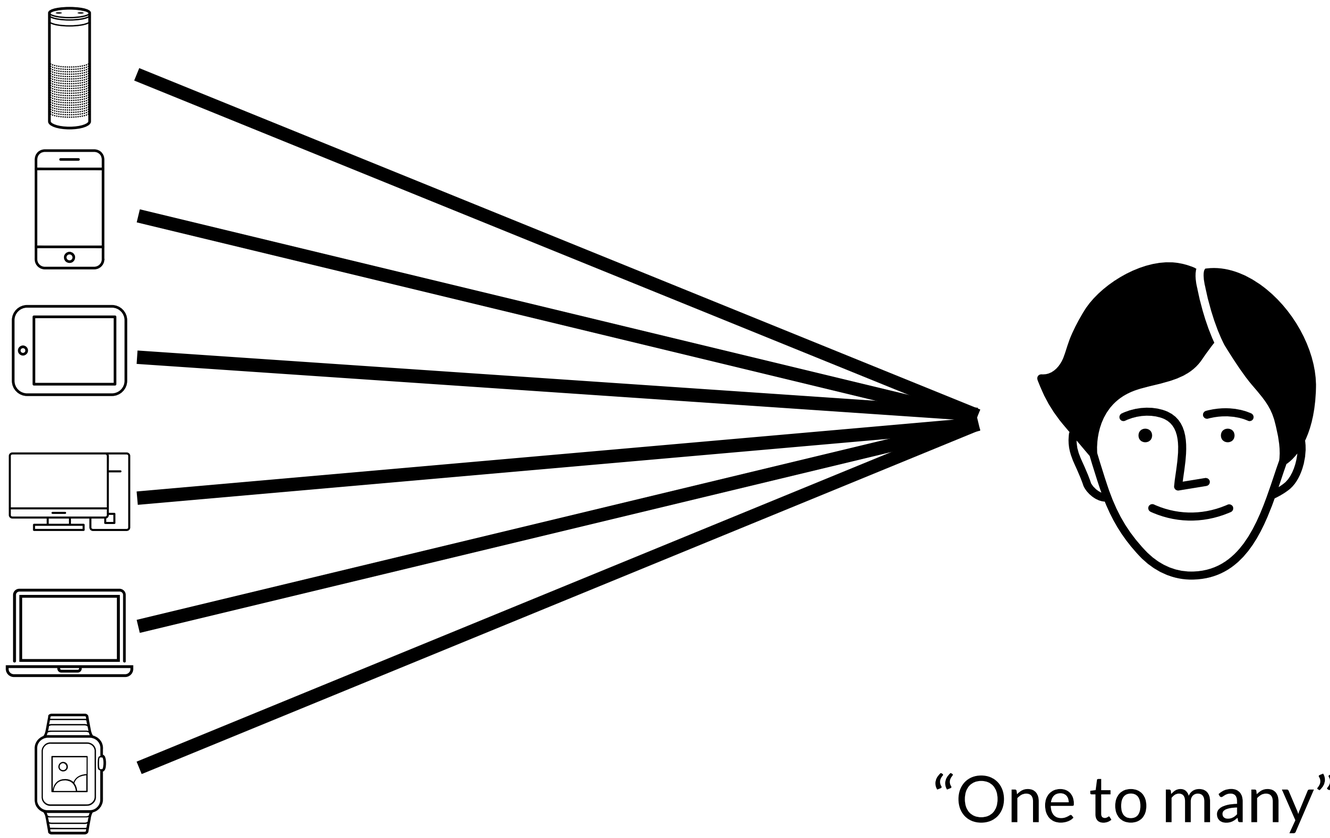


Third wave: ubiquitous computing

Third wave: ubiquitous computing

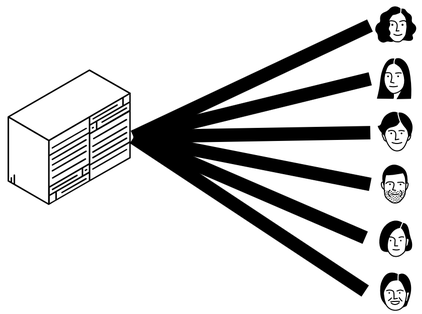


“One to many”

Three waves of computing

1

Mainframe computing



“Many to one”

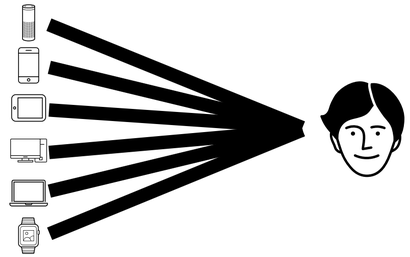
2

Personal computing

“One to one”

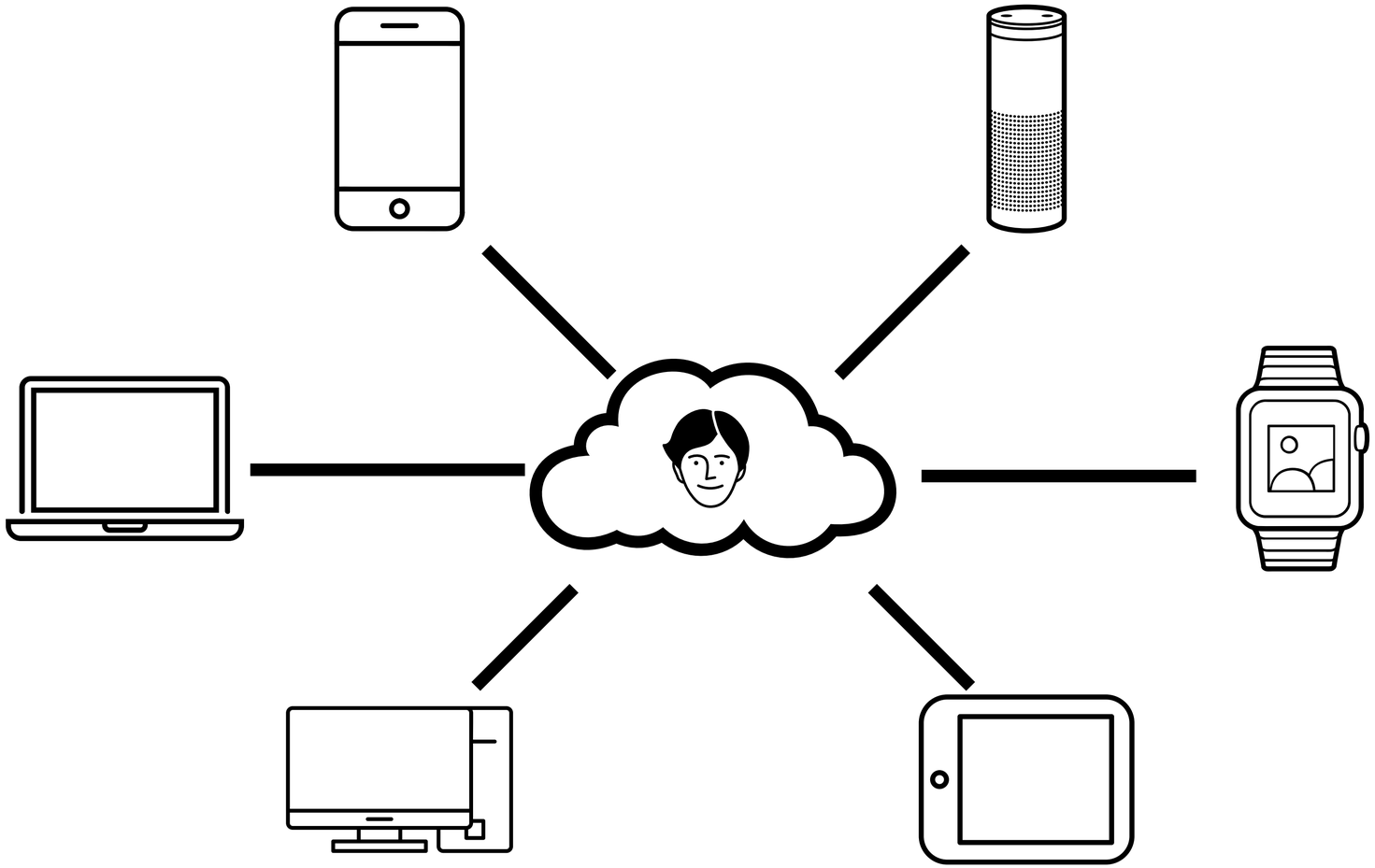
3

Ubiquitous computing



“One to many”

One to many, synced over the cloud



Today’s class

- Defining ubiquitous computing
- Course overview
- Break
- Discussion on the readings
- Project discussion

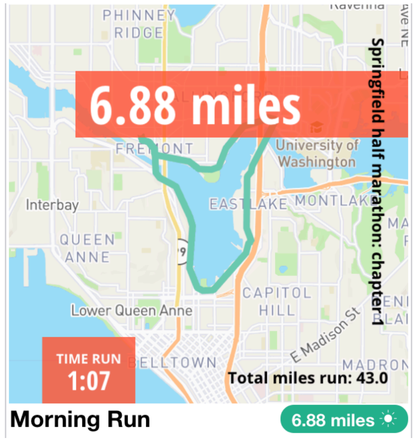
Course Overview

- Who we are
- Staying in touch
- Readings
- Daily structure
- Project
- Grading
- Calendar overview

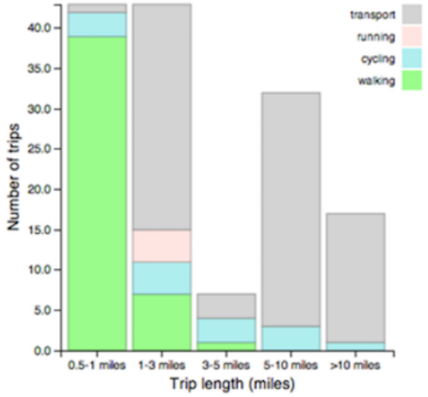
Who I am

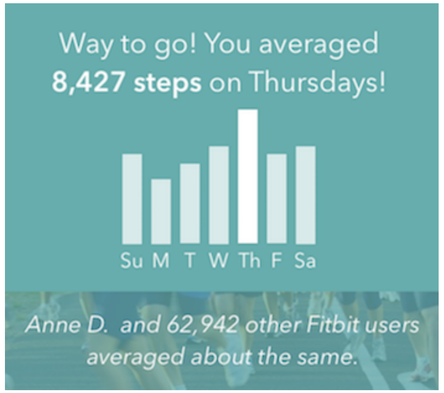
- Ph.D. Computer Science & Engineering, University of Washington 2018
- B.S. Computer Science, University of Virginia 2012
- Joined UCI Informatics last July as an Assistant Professor
- Internships at Microsoft & Adobe

Who I am


6.88 miles
Springfield half marathon: chapter 1
PHINNEY RIDGE
FREMONT
University of Washington
Interbay
EASTLAKE
MONTLAKE
QUEEN ANNE
CAPITOL HILL
Lower Queen Anne
E Madison St
BELLTOWN
MADRONA
TIME RUN
1:07
Total miles run: 43.0
Morning Run
6.88 miles


Todays Challenge: Eat something cooked in an oven.
Like · Comment
Seen by 19
Would you share the recipe for the zucchini crab cakes?
· Like
Sure!! They were super easy!
http://pinterest.com/pin/143552306847641549/


transport
running
cycling
walking
Number of trips
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.5-1 miles
1-3 miles
3-5 miles
5-10 miles
>10 miles
Trip length (miles)


Way to go! You averaged
8,427 steps on Thursdays!
Su M T W Th F Sa
Anne D. and 62,942 other Fitbit users averaged about the same.

Who I am

- Broadly speaking, I work on Human Computer Interaction (HCI)
- Ubiquitous Computing is one of my sub-areas of focus
- I examine how ubiquitous technology can be best designed to help people achieve their goals

Around the room!
Say your name, program & year,
and something fun about you

Staying in touch

- Web: http://inf241-fa18.depstein.net/ (or http://depstein.net/241/)
- Email me: epstein@ics.uci.edu
- Slack: https://uci-inf241-fa18.slack.com/
  - Information will go out to Slack first, and may not go out over email
- Office hours: generally by appointment (send me an email)
  - I'll make dedicated appointment slots for this week to discuss project ideas

Readings

- Each week will cover a different topic connected to ubiquitous computing
- Readings will emphasize:
  - 1-2 *framing* papers which summarize and contextualize the topic
  - 2 *recent* papers of more specific contributions
- Read all framing papers and 1 of the instance papers
  - Discussion will be expected throughout the course
- Doing the reading is a major component of the course
  - No assignments or exams

Readings

- Post “reading reports” to Slack the Sunday night before class
- Generally short (200-400 words)
- Discussion of what the reading(s) made you consider;
  not a summary of the reading(s)
  - What aspects of the work were particularly well done?
  - How might this research have informed other research or products you’ve seen?

Readings

- A group of you (3-4) will lead the discussion each week
- Your goal is to be “the expert” on each week’s readings
  - Guide the discussion to cover key points made in the reading
  - Bring in points discussed in the reading reports
  - Bring in outside readings, as appropriate
  - Ensure a range of voices/perspectives are given the opportunity to speak
- Divide the recent readings among your group,
  but all read the framing readings

Readings

- I have identified framing readings for each week
- Discussion leaders can choose the recent readings
  - I have provided some suggestions, but you can also suggest another reading
- Let me know on Canvas what topics you are most (and least) interested in leading
  - Complete this survey ASAP, next week's discussion leaders and recent readings have not been selected
- If time allows, I'll leave time for this at the end of class

Daily structure

- 5:00-5:15—announcements, setting the stage for the day’s discussions
- 5:20-6:00—discussion on the framing readings, split in half
- 6:00-6:20—break
- 6:20-7:00—discussion on the recent readings, split by paper
- 7:05-7:50—synthesis as a large group, project presentations/updates
- The schedule may change slightly each week

Project

- Expected to be groups of 2
  - Singles and groups of 3 considered
  - Singles very highly discouraged
- Proposal, milestone, poster, report

Project

- The project is intended to produce *novel research* in Ubiquitous Computing
  - Or implementation, study design, etc. in support of later novel research
- For example, you might:
  - Implement a new ubiquitous technology, such as a novel method for sensing
  - Develop and execute a study which contributes some understanding of how people use ubiquitous technology
  - Rigorously evaluate a piece of existing ubiquitous technology
  - Design a ubiquitous technology which critically examines people's practices

Project

- Some of you may have ongoing work that is relevant
  - It's fine, even encouraged, to "count" an ongoing research project for this class
  - So long as it connects to ubiquitous computing in some way
  - You may even be able to recruit classmates to help with your work!
- But I expect that a research project will be new to many of you
  - I'll create a Slack channel shortly with some project ideas
  - If you have an idea already, you can post it to that channel

Grading

- 50% group project
  - 5% project proposal, 10% milestone report, 10% final poster, 25% final report
- 30% reading reports
- 10% leading discussion
- 10% participation

Calendar overview

- This week: history of ubiquitous computing
- 6 weeks of specific topics
- Final week: the future of ubiquitous computing

Calendar overview

- No class January 21 (MLK Day) or February 18 (President’s Day)
- Instead, project milestones are due those weeks
  - Proposal due two weeks from today (MLK day)
  - Mid-quarter milestone due President’s Day
- Very short group presentations (<5 min) the following week
  - Informal presentations
  - Aimed to learn what classmates are working on and to get feedback

Course Overview

- Who I am
- Staying in touch
- Readings
- Daily structure
- Project
- Grading
- Calendar overview

Course Overview

- If you expect lectures and assignments on processing signals, printing nanomaterials, etc., you will be sorely disappointed
  - In part because I do not have the background necessary to teach such skills
  - But I also find creating new knowledge much more fulfilling
- You may use these skills in your projects,
  but you will be expected to pick them up on your own

Course Overview

- Instead, you will leave this class with:
  - Context about where ubiquitous computing fits in the history of technology
  - A better understanding of how to make ubiquitous technologies useful for people
  - The ability to critique a new device or system and improve upon it
  - Ideally, a research contribution in ubiquitous computing through your project

Break

Having a good discussion

- Be engaged, actively listen
- Be courteous to others, help make sure everyone gets a chance to speak
- Understand that there are a diverse set of perspectives in the class
- When possible, support your statements from the readings
- We are all trying to learn here! It’s okay to change your perspective or say something that others disagree with

Discussion on the readings

Computer for the 21st century

- The “Sal” vignette describes goals still pursued by technology today
  - Finding my phone
  - Using an application across multiple devices
  - Connected personal IoT devices
  - Sensing in the environment
  - Multi-factor authentication

Computer for the 21st century

- Tabs, pads, and boards: do we have these today?
- Calm computing: rarely achieved, often not the goal
- Networked computing: short range (bluetooth), wifi, fast connection (wired)
- Devices tend to be owned rather than shared
- Device addiction is still very much a concern

Computer for the 21st century

About the author

- Mark Weiser
- Chief scientist, Xerox PARC
- Widely regarded as the identifier of ubiquitous computing
- Passed away in 1999

Charting the past, present, and future

- Progress in three areas, though there are still open challenges:
  - Natural interfaces
  - Context-aware computing
  - Automated capture and access
- A need to push toward everyday computing,
  which is informal and less structured

Charting the past, present, and future

- No solution for how to represent context
- Is “everyday computing” calm?
  - Calm computing might violate people’s trust because they do not know it is there
- It is difficult to effectively develop *and* evaluate a ubicomp system

Charting the past, present, and future

About the authors

- Gregory Abowd
- J.Z. Liang Professor,
  School of Interactive Computing,
  Georgia Tech
- Modern leader in the field
- Advises many Ubicomp Ph.D.'s,
  including Gillian Hayes
- Elected to the CHI Academy in 2008

Charting the past, present, and future

About the authors

- Elizabeth Mynatt
- Distinguisted Professor,
  School of Interactive Computing,
  Georgia Tech
- Leader in personal health informatics
- Elected to the CHI Academy in 2009

Project discussion

Project discussion

- Opportunity for a 30-second pitch now
- I’ll make a channel on Slack to recruit peers
- I’ll stick around for a bit if you want to discuss project ideas

IN4MATX 241: Ubiquitous Computing

Week 1:
History of Ubiquitous Computing

Daniel Epstein